Ocean Dynamics: IWISE DRI

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LONG-TERM GOALS

To gain a more complete understanding of ocean dynamical processes, particularly at fine-scale, through comparison of high, mid- and low-latitude observations, near the sea surface, in the main thermocline, and near the sea floor.

OBJECTIVES

To identify the phenomena involved in the cascade of energy from meso-scales to turbulent scales. In particular, we wish to quantify the relationship between fine-scale background conditions and the occurrence of microscale breaking.

APPROACH

Progress is achieved through a steady-state cycle of instrument development, field observation and data analysis. The primary instruments employed include Doppler sonar and rapidly-profiling CTD's. Our instruments produce information that is quasi-continuous in space and time, typically spanning two decades in the wavenumber domain. This broad band space-time coverage enables the investigation of multi-scale interactions.

WORK COMPLETED

Our major accomplishment has been participation in the Summer 2011 IWISE cruise to Luzon Strait on the RV Revelle. We focused on the development of deep-ocean turbulence in an outflow channel in Luzon Strait, (Fig 1a, b) where numerical simulations suggested energetic turbulence would be present. We employed the MPL-SIO Fast CTD (Fig 1b) to study the phenomenon, along with the HDSS sonars on the Revelle. The systems performed well for the duration of the experiment. Over 800 CTD profiles were collected, to depths as great as 1900m.

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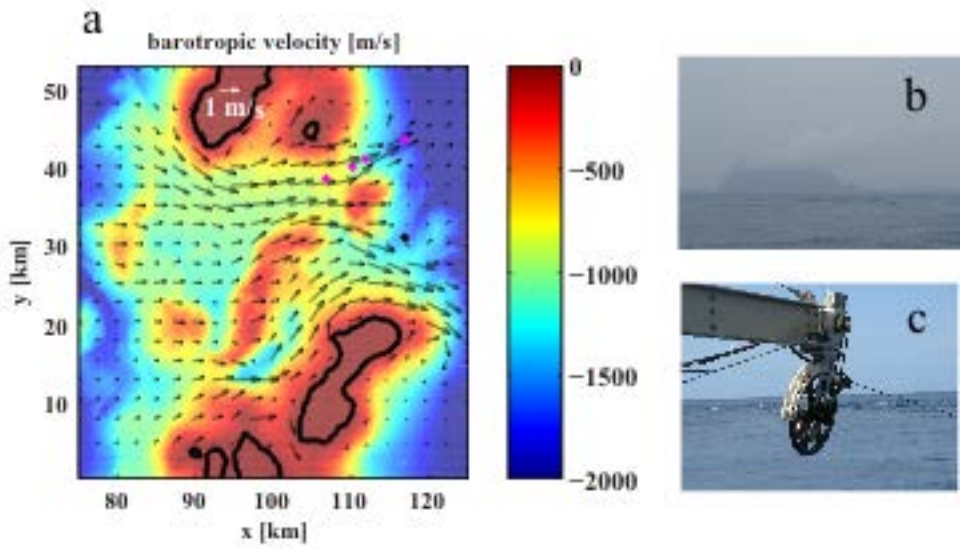

Figure 1. a. A topographic map of central Luzon Strait showing barotropic tidal flow vectors from the MIT cgm. Magenta dots show the location of stations in the North Outflow Channel of the Ridge. b. Proximity to local islands rendered ship maneuvering difficult. c. The motorized sheave on the Fast CTD. In the background is the surface disturbance caused by the internal lee-waves.

RESULTS

It was found that mixing is associated with a variety of flow phenomena in the outflow channel, Fig.2. Thanks to the establishment of a complex lee wave pattern, mixing is not confined to the "near bottom" region. The full water column feels the effect of the 1000 m deep topography. Depth-integrated mixing rates approach 8 Watts/m^2, perhaps the highest deep-sea values recorded to-date.

IMPACT/APPLICATIONS

The lee wave generated in the Luzon outflow channel was sufficiently strong to modify the propagation of sea surface waves, more that 1000m above the topography (Fig 1c). This is perhaps the first example of a surface signature of deep topography NOT associated with propagating solitary waves.

TRANSITIONS

We have successfully recruited Ms. Ruth Musgrave, an extremely promising SIO student, to work on data and modeling aspects of IWISE 2011. She will be co-advised by Profs Jen MacKinnon and R. Pinkel.

RELATED PROJECTS

Vietnam DRI, Winter 2014 Cruise

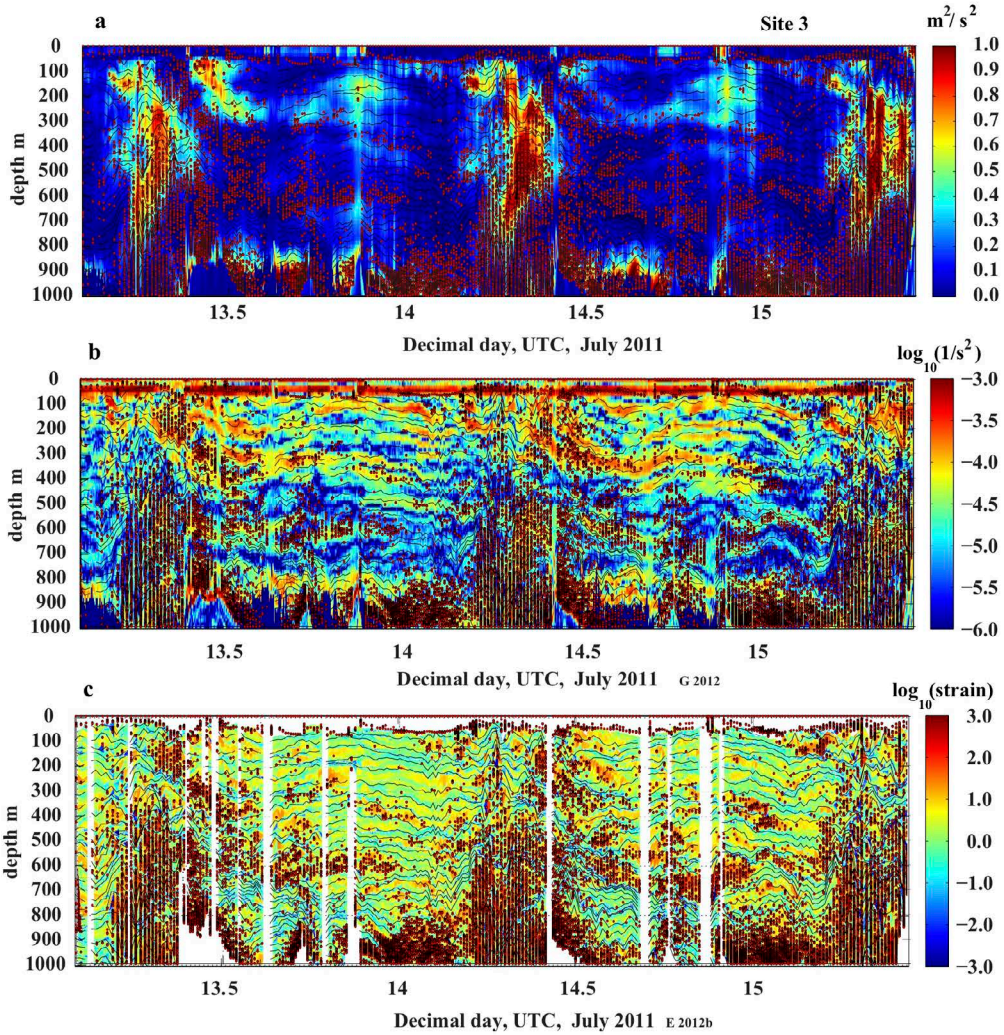

Figure 2. Maps of horizontal Kinetic energy, a, $log_{10}(shear^2)$, b, and $log_{10}(strain)$ for site III in the N. Outflow Channel. Overturns of vertical scale 20 m or larger are indicated by the dots.

PUBLICATIONS

Klymak, J.M., S. Legg, M.H. Alford, M. Buijsman, R. Pinkel, and J.D. Nash. 2012 The direct breaking of internal waves at steep topography. Oceanography, 25-2,150-160.

Pinkel, R., M.Buijsman and J.M. Klymak. Breaking topographic lee waves in a tidal channel in Luzon Strait. Oceanography, 25-2, 160-166.

HONORS/AWARDS/PRIZES

AMS Stommel Award
Fellow AMS